T 101: Neutrino Physics VIII

Time: Friday 9:00–10:30 Location: VG 3.103

T 101.1 Fri 9:00 VG 3.103

Search for Light Sterile Neutrinos with the KATRIN Experiment — •Christoph Köhler[1,2], Xaver Stribl[1,2], and Susanne Mertens[1,2] for the KATRIN-Collaboration — [1]Technical University of Munich — [2]Max Plabck Institute for Nuclear Physics

Light sterile neutrinos with a mass at the eV-scale could explain several anomalies observed in short-baseline neutrino oscillation experiments. The Karlsruhe Tritium Neutrino (KATRIN) experiment is designed to determine the effective electron anti-neutrino mass via the kinematics of tritium β–decay. The precisely measured β-spectrum can also be used to search for the signature of light sterile neutrinos.

In this talk we present the status of the light sterile neutrino analysis of the KATRIN experiment. We describe the method used to study the first five measurement campaigns. The obtained results are compared to findings of complementary experiments and anomalies in the field of light sterile neutrinos.

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T 101.2 Fri 9:15 VG 3.103

The new detector section for KATRIN for the keV sterile neutrino search — •Simon Gentner — Karlsruhe Institut für Technologie (KIT)

At the Karlsruhe Institute of Technology (KIT) a full-scale replica of the KATRIN experiment's detector system was developed to pretest the innovative TRISTAN detectors. The replica system facilitates comprehensive testing and calibration of currently three TRISTAN detectors under controlled conditions, ensuring their optimal performance prior to integration into the KATRIN beamline in 2026 which will enhance KATRIN's sensitivity in the search for keV-scale sterile neutrinos. Critical operational parameters, including energy resolution, count rate capabilities, and data aquisition, are meticulously evaluated. Preliminary results indicate that the TRISTAN modules achieve exceptional high-resolution beta spectroscopy, essential for precise neutrino mass measurements and the exploration of potential new physics. This presentation will discuss the setup, detailed test procedures and initial results that emphasize the central role of the TRISTAN upgrade in advancing neutrino research.

T 101.3 Fri 9:30 VG 3.103

Bayesian analysis of KATRIN neutrino mass data using a neural network — Philipp Krönert[1], Susanne Mertens[2], Oliver Schulz[3], and •Alessandro Schwemmer[2] for the KATRIN-Collaboration — [1]Helmholtz-Institut für Strahlen- und Kernphysik, Bonn — [2]Physik Department, Technische Universität München, Garching — [3]Max-Planck-Institut für Physik, München

The Karlsruhe Tritium Neutrino (KATRIN) experiment probes the effective electron anti-neutrino mass by precisely measuring the tritium beta-decay spectrum near its endpoint. A world-leading upper limit of $0.45\,\mathrm{eV\,c^{-2}}$ (90 % CL) has been set with the first five measurement campaigns following a frequentist analysis procedure. A neural network has been developed in this context, enabling fast and precise model calculations. Utilizing this neural network, a new Bayesian framework has been built in the Julia programming language. It allows for efficient sampling of the posterior density using Hamiltonian Monte Carlo methods implemented by BAT.jl. In this talk, we will present the current development status of the Bayesian framework and its application to the analysis of the first five KATRIN measurement campaigns.

This work is supported by the Helmholtz Association and by the Ministry for Education and Research BMBF (grant numbers 05A23PMA, 05A23PX2, 05A23VK2, and 05A23WO6).

T 101.4 Fri 9:45 VG 3.103

Sensitivity studies for a next-generation neutrino-mass experiment using tritium β-decay — •Svenja Heyns for the KATRIN-Collaboration — Karlsruhe Institute of Technology, Germany

The Karlsruhe Tritium Neutrino (KATRIN) experiment probes the absolute neutrino mass scale by precision spectroscopy of tritium β-decay. With a total of 1000 days of measurement by the end of 2025, a final sensitivity better than $300\,\mathrm{meV/c^2}$ (90% C.L.) is anticipated by the collaboration.

Taking next steps in enhancing the sensitivity, for instance towards the regime of inverted mass ordering, requires novel technological approaches to significantly improve statistics, energy resolution, and background suppression. We explore two key strategies: (1)implementing a differential detector with sub-eV energy resolution (quantum sensor detector array, time-of-flight measurement) to resolve each electron's energy individually while covering the entire energy interval of interest simultaneously and (2)exploring a large-volume atomic tritium source. In this presentation, we introduce the conceptual framework for simulations to investigate the requirements by technology and limits by physics to confine the achievable sensitivity on the neutrino mass with a differential measurement. *This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Initiative and Networking Fund (W2/W3-118).*

T 101.5 Fri 10:00 VG 3.103

Update on the ECHo Experiment — •Raghav Pandey — Kirchhoff Institute for Physics, Heidelberg University

In the ECHo experiment large arrays of low temperature metallic magnetic calorimeters (MMCs) enclosing Ho-163 are used for the high resolution measurement of the electron capture spectrum. The goal of the experiment is to achieve the sensitivity to detect an extremely small spectral shape distortion in the end point region due to a finite neutrino mass. The first phase, ECHo-1K was designed to test the properties and reproducibility of MMCs with implanted Ho-163 and the sensitivity to the effective electron neutrino mass. For 6 months between December 2019 and June 2020, Ho-163 events were acquired using about 50 MMC pixels enclosing about 1 Bq Ho-163 each. Data reduction methods were developed and applied on the acquired dataset. 'Quality Control' parameters have been defined to track and quantify the effect of the data processing algorithms devised and the selection criteria invented to eliminate unsuitable data. A Ho-163 electron capture spectrum was compiled containing more than 2×10^8 events and showing an energy resolution of 7.8 eV.

T 101.6 Fri 10:15 VG 3.103

Data reduction of the ECHo-1k-Au data — •Rasmus Jeske — Kirchhoff Institute for Physics, Heidelberg University — ECHo Collaboration

For the ECHo-1k experiment two metallic magnetic calorimeter arrays with Ho-163 implanted in the absorber have been used. They differ in the host materials in which Ho-163 was implanted, Au and Ag. Data reduction algorithms and quality control procedures have been developed and characterized for the analysis of the data acquired with detectors having Ho-163 implanted in silver. We present the application of the data reduction protocol to the data acquired with detector having Ho-163 implanted in gold, ECHo-1k-Au data. We discuss the criteria to identify and eliminate triggered noise and other possible spurious events along with the efficiency and stability of the filters. From the analysis of the obtained spectra we derive the properties of the detectors in term of energy resolution and energy calibration over the course of the experiment. In addition, we demonstrated that the probability of having spectral shape artifacts in the endpoint region due to misinterpreted bad events is smaller than the statistical error.